Long-Term Variable Milfoil Management and Control Plan for LEES POND Moultonborough, New Hampshire Carroll County

Prepared by: New Hampshire Department of Environmental Services (DES),
in consultation with the
New Hampshire Fish and Game Department (F&G)
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PROBLEM STATEMENT

Exotic aquatic plants pose a threat to the ecological, aesthetic, recreational, and economic values of lakes and ponds (Luken & Thieret, 1997, Halstead, 2000). According to the 2006 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM), "exotic macrophytes are non-native, fast growing aquatic plants, which can quickly dominate and choke out native aquatic plant growth in the surface water. Such infestations are in violation of Env-Ws 1703.19, which states that surface waters shall support and maintain a balanced, integrated and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region" (DES, 2006).

Though exotic aquatic plants can negatively impact an aquatic system, native aquatic plants are beneficial to the aquatic ecology of waterbodies. Diverse assemblages of native aquatic plants are a source of oxygen to the system, they provide stabilizing root systems to minimize erosion and turbidity, and they provide food and habitat for aquatic life.

Variable milfoil (*Myriophyllum heterophyllum*) became established in Lees Pond in Moultonborough, New Hampshire in 1975. The plant quickly colonized this lake, forming dense stands of milfoil from near shore to depths of about 10 feet. Recent control measures have greatly reduced the overall infestation to only small patches of growth today. Figure 1 illustrates the distribution of variable milfoil infestations in this waterbody as of fall 2007.

Following is a summary of each area indicated in Figure 1:

Area A- Located along the northeast shoreline of the pond, Area A covers approximately 1.3 acres, and has patchy growth of variable milfoil at the 25% cover level.

Area B- This area is located southeast of Area A. It spans roughly 1 acre, and is present as thick growth, with about 60% cover.

Area C- Area C is the largest single infested area in the lake. The milfoil covers just over 2.3 acres, and includes several large patches at a 45% cover level.

Area D- This site is in the southeast corner of the pond. It covers about 0.95 acres, and variable milfoil is present at the 30% cover level.

Area E- This area is located along the south central shoreline of the pond and is 0.5 acres in size, with about 25% variable milfoil cover.

Area F- This 1.8 acre patch of milfoil is present at the 65% cover level in the southwest corner of the pond.

Area G- This area abuts the southwestern shoreline of the island and covers 2.2 acres. Variable milfoil percent cover ranges from approximately 75% at the tip of the island, to less than 25% in the cove of the island.

Area H- This area is along the northwestern edge of the island, and is 0.59 acres in size. Variable milfoil is present at about a 20% cover level here.

Area I- This area is located just south of Area C. It spans just under 0.59 acres and is the only larger treatment area that does not abut the shoreline. Milfoil is present at the 30% cover level in this area.

Individual Points- The individual points around the pond indicate areas where small patches or groupings of a few stems of milfoil are present.

In terms of the impacts of the variable milfoil in the system, there are several (37) houses around the shoreline of Lees Pond, with mostly seasonal cottages, though there are a few year-round dwellings. There are also two back lots with lake rights. Many of these abut areas of moderate to dense variable milfoil growth. Lake residents have expressed concerns about the variable milfoil in the pond. Residents indicate that the variable milfoil is dense at the boat launch, and causes impediments to navigation, in addition to spreading fragments. Additionally, fishing spots around the lake are impaired by the milfoil, as are docks and boating areas. Milfoil is also abundant near the outlet channel to Lake Winnipesaukee, and as such, Lees Pond acts as a regular source of milfoil fragments to downstream waters.

The invasive plant infestation in this pond has increased steadily since it was first identified in Lees Pond. In the past few years, DES and the lake association, working with licensed contractors, have gotten the infestation reduced in size and under control. The lake association plans to be very active with diving and hand-removing the milfoil, and using suction harvesting, but an herbicide treatment is needed to further reduce a few stubborn patches of growth in the pond before these non-chemical approaches begin in earnest.

At this time, there are no data and no observed problems with the biological integrity of the aquatic community as a result of the variable milfoil infestation or past controls. No biological integrity surveys have been conducted, however, as part of this plan preparation.

PURPOSE

In August 2007, the Lees Pond Association requested matching funds from the Department of Environmental Services to conduct an aquatic plant control project during the spring of 2008 to control areas infested with variable milfoil.

The purposes of this exotic aquatic plant management and control plan are:

1. To identify the waterbody's beneficial use areas, including essential aquatic habitat, designated conservation zones, swimming areas, boat access sites, and boating use areas;
2. To present the aquatic macrophyte distribution map, including both native and exotic species;
3. To identify short-term and long-term exotic aquatic plant control goals that protect and conserve the lake's beneficial uses;
4. To recommend exotic plant control actions that meet the goals outlined in this plan; and
5. To recommend monitoring strategies to determine the success of the control practices over time in meeting the goals.

This plan also summarizes the current physical, biological, ecological, and chemical components of Lees Pond and the social and ecological impacts of the milfoil infestation. Appendix A details the strategies available for waterbodies with exotic species, and provides more information on each of the activities that are recommended within this plan.

GOALS/OBJECTIVES OF MILFOIL CONTROL ACTIONS

The intent of this strategic plan is to outline a plan to eventually eradicate variable milfoil from Lees Pond over time through the use of Integrated Pest Management Strategies (IPM), while maintaining native plant communities whenever variable milfoil control actions are being implemented. To achieve this goal, we recommend the following:

1) Reduce variable milfoil infestations in Areas A through I in Figure 1 to less than ¼ acre in size and less than 10% cover (essentially small patches or scattered stems in each area) with the use of 2,4-D or other aquatic herbicide in 2008.

2) To eradicate variable milfoil infestations located at individual points by hand-removal, suction harvesting, and/or and benthic barrier placement in 2008.

3) To eventually eradicate variable milfoil infestations throughout the pond by 2012 by performing non-chemical variable milfoil control actions on any exotic plants remaining after actions 1 and 2 above, using hand-removal, benthic barriers, and/or diver-assisted suction harvesting in August 2008, and annually thereafter if new stems or localized patches are present.

To maintain a Weed Watcher program and Lake Host Program for the pond.

Town Support

The Town of Moultonborough has been very supportive of variable milfoil control efforts in Lees Pond. The town has been supportive financially by offering $1,000 of matching funds for each year.

Lees Pond Improvement Association Support

Lees Pond has an active lake association. They participate in the DES Volunteer Lake Assessment to monitor water quality, in the Weed Watcher program to track plant growth, and in the Lake Host Program to inspection boats as they enter and leave Lees Pond.

In 2006, divers that live on the pond became trained in variable milfoil hand harvesting by experienced divers in this field, and have spent many hours performing hand-removal of variable milfoil in the lake. In 2007, the lake association coordinated and paid for diver-assisted suction harvesting work in the lake to reduce some of the smaller patches of variable milfoil.

The lake association is also committed to performing follow-up monitoring for milfoil re-growth, and working with DES to coordinate hand-removal and benthic barrier placement for further variable milfoil control.

WATERBODY CHARACTERISTICS

The following table summarizes basic physical and biological characteristics of Lees Pond.

General Lake Information	
Lake area (acres)	179.2
Watershed area (acres)	17,656.5
Shoreline Uses (residential, forested, agriculture)	Residential, forested
Max Depth (ft)	37.3
Mean Depth (ft)	12.2
Trophic Status	Mesotrophic
Color (CPU) in Epilimnion	43
Clarity (ft)	9.9
Flushing Rate (yr^{-1})	12.9
Natural waterbody/Raised by Damming/Other	Natural
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	*Myriophyllum heterophyllum*
Infested Area (acres)	Approximately 11.3 acres
Distribution (ringing lake, patchy growth, etc)	Dense patches of infestation in several locations of pond, with smaller scattered patches or single stems throughout the pond denoted in Figure 1.
Sediment type in infested area (sand/silt/organic/rock)	Silty/organic
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	New England Bluet (Rare) Reversed Bladderwort (State Threatened) Common Loon (State Threatened) Purple Martin (State Endangered)
Area of Littoral Zone (acres)	86.7
Area of Profundal Zone (acres)	78.7
Area of Macrophyte Coverage (native or otherwise) of Plants in Littoral Zone	78.5
% of Littoral Zone with Macrophyte Cover	91
% of Macrophyte cover comprised of invasives	14

% of Littoral Zone with Variable Milfoil Cover	13

An aquatic vegetation map and key from a September 25, 2007 survey by the DES Biology Section is shown in Figure 2. A bathymetric map is shown in Figure 3.

BENEFICIAL (DESIGNATED) USES

In New Hampshire, beneficial (designated) uses of our waterbodies are grouped into five general categories: Aquatic Life, Fish Consumption, Recreation, Drinking Water Supply, and Wildlife (CALM).

Of these, Aquatic Life and Recreation are the ones affected by the presence of invasive plants like variable milfoil.

AQUATIC LIFE

The goal for aquatic life support is to provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of the region.

FISHERIES AND WILDLIFE

Lees Pond is dominated by warmwater species including largemouth and smallmouth bass, black crappie, chain pickerel, yellow perch, bluegill, pumpkinseed sunfish, and brown bullhead. The primary fishery is for largemouth bass, crappie, and pickerel.

Lees Pond is enjoyed by both transient and local fisherman. Figure 4 illustrates the common fishing areas on Lees Pond, as presented by members of the lake association that track activity on the pond. Some of the areas indicated as prime fishing habitat by local fishing enthusiasts do fall within zones that are heavily impacted by variable milfoil growth.

A Natural Heritage Inventory review showed three wildlife species of interest or concern in the general area: the New England bluet, reversed bladderwort, common loon, and purple martin.

The New England bluet was documented downstream of Lees Pond in Lake Winnipesaukee. The record was from 2002. General comments about the bluet indicate that the population appears to be widespread in the vicinity, and secure. Because only a small amount of herbicide will be used upstream in Lees Pond, it is expected that the herbicide concentration will be diluted to a point where it will not be a concern downstream. Lees Mills has done numerous historical herbicide treatments, apparently with no detriment to this damselfly population. By the time of the treatment (late May or early June), the bluets are already airborne, and out of the water. Egg laying is likely in July, and by that point the herbicide concentration will likely be below detection limits, particularly in this flow-through area. Other non-chemical approaches will not impact or target this species.

The common loon is a regular visitor to Lees Pond. Only small areas of variable milfoil growth around the pond will be targeted for control, and the balance of the pond will not be targeted for herbicide treatment. Native plants abound in Lees Pond, providing suitable habitat for the fish species which are they prey of the common loon. Other non-chemical approaches will not impact or target this species.

The record for the state threatened purple martin was within the watershed of Lees Pond, and not directly tied to the waterbody (found near an apple orchard). We do not anticipate the herbicide treatment or non-chemical controls of variable milfoil in Lees Pond will affect this avian species.

RECREATION USES AND ACCESS POINTS

Lees Pond is used for numerous recreational activities, including boating, fishing, swimming, and water skiing by both pond residents and transient boaters. Figure 5 illustrates the location of the public access site. There is one designated public access for boats on the northeastern side of the pond. Small motor boats, as well as kayaks and canoes can use this facility. Generally 1-2 transient boaters can be found visiting the lake each day during the summer months. There is limited parking for vehicles with trailers. There are generally a handful of small resident owned powerboats on the lake each year, and numerous canoes, kayaks, and row boats. Figure 6 illustrates the typical boat paths for the pond.

There are a few small private swim beaches located on private properties around the pond. There are 10 floating docks and swim platforms around the pond as well, and roughly 19 docks around the pond. Figure 7 shows the locations commonly used for swimming, and the locations of swim platforms and docks on Lees Pond.

MACROPHYTE EVALUATION

The littoral zone is defined as the nearshore areas of a waterbody where sunlight penetrates to the bottom sediments. The littoral zone is typically the zone of rooted macrophyte growth in a waterbody.

The littoral zone of Lees Pond is characterized by a mix of native and non-native (variable milfoil) plant growth (Figure 2). Native species include a mix of floating plants (yellow and white water-lilies, watershield, floating hear), emergent plants (bur-reed, pickerelweed, cattail), and submergent plants (pondweed, bladderwort, Coontail, mermaid-weed). Native plant communities are mixed around the entire lake, and are characterized as ‘common/abundant’ by the DES.

A New Hampshire Natural Heritage Bureau survey showed one plant as a concern in the vicinity of Lees Pond (reversed bladderwort). Reversed bladderwort is listed as state threatened, and the record for this plant was upstream of Lees Pond. DES has conducted several plant mapping activities in this area, and this particular plant species has not been observed, though other bladderwort species are fairly common in the pond. DES will conduct a site inspection in the general vicinity of the bladderwort sighting before an herbicide treatment is conducted, to verify if it is present or not. If the bladderwort is present, but in an upstream location, it will not be

impacted by an herbicide treatment in Lees Pond. Other non-chemical approaches will not impact or target this species.

HISTORICAL CONTROL ACTIVITIES ON THIS WATERBODY:

Contractor	Management Type:	Date	Treatment Area (acres)
Aquatic Control Technology, Inc.	Herbicide: Diquat	6/4/03	35
Aquatic Control Technology, Inc.	Herbicide: 2,4-D	6/7/05	30
Aquatic Control Technology, Inc.	Herbicide: 2,4-D	6/7/06	10

MILFOIL MANAGEMENT OPTIONS

The control practices used should be as specific to milfoil as feasible. No control of native aquatic plants is intended.

Exotic aquatic plant management relies on a combination of proven methods that control exotic plant infestations, including physical control, chemical control, biological controls (where they exist), and habitat manipulation. Integrated Pest Management Strategies (IPM) are typically implemented using Best Management Practices (BMPs) based on site-specific conditions so as to maximize the long-term effectiveness of control strategies. Descriptions for the control activities are closely modeled after those prescribed by the Aquatic Ecosystem Restoration Foundation (AERF) (2004). This publication can be found online at http://www.aquatics.org/aquatic_bmp.pdf. Criteria for the selection of control techniques are presented in Appendix A. Appendix B includes a summary of the exotic aquatic plant control practices used by the State of New Hampshire. DES has evaluated the feasibility of potential control practices on Lees Pond. The following table summarizes DES' control strategy recommendations for Lees Pond.

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	Use on Lees Pond
Restricted Use Areas	Not recommended as variable milfoil patches are too widely distributed throughout pond.
Hand-pulling	Hand-pulling is already an important component of variable milfoil control in Lees Pond. As mentioned previously, a group of lake association residents was trained by knowledgeable milfoil control divers how to successfully hand-pick variable milfoil. Lake residents are currently implementing this method in Lees Pond. DES recommends additional monitoring and hand-pulling after the herbicide treatment to target individual stems or small patches

Control Method	Use on Lees Pond
	of growth that have been identified in Lees Pond (Figure 1). Also, diver assisted suction harvesting is recommended for larger patches of milfoil not targeted by herbicide treatment, and for any re-growth following treatment.
Mechanical Harvesting/Removal	For Lees Pond, mechanical harvesting is not recommended due to the threat of spreading variable milfoil to uninfested areas of the lake through the generation of fragments.
Benthic Barriers	DES recommends the use of small benthic barriers, if needed, in Lees Pond. This method will be infeasible in some areas of the pond due to flow (inlet streams) or bottom sediment (very organic sediments may result in excessive gas release and billowing of the barrier). DES will work with the lake association to determine the locations where benthic barriers would be best used.
Herbicides	For Lees Pond, herbicide use is recommended as primary treatment due to extent of infestation. The aquatic herbicide 2,4-D is recommended in 2007 and in 2008 due to the nature of the pond. Diquat was previously used, but because the pond is colored and somewhat turbid with detritus, this chemical was not effective in controlling the milfoil as it quickly binds to the organic material in the water column and the sediments. 2,4-D has been proven to be a good herbicide to control variable milfoil and reduce its footprint in Lees Pond.
Extended Drawdown	Drawdown is not an effective control method for variable milfoil, and would be infeasible in Lees Pond due to a lack of impoundment structure.
Dredge	Not recommended due to nature of exotic plant distribution, the cost, or the ancillary ecological impacts that the dredge could have.
Biological Control	There are no approved biological controls for variable milfoil at this time in New Hampshire.
No Control	At this point in time, many hours and a lot of resources have gone into controlling the variable milfoil in Lees Pond. To opt for a 'no control' option at this juncture would only mean an increase in variable milfoil in Lees Pond, and the loss of any progress made as a result of past efforts.

EXOTIC AQUATIC PLANT CONTROL PLAN

An evaluation of the size, location, and type of variable milfoil infestation, as well as the waterbody uses was conducted by DES during September 21, 2006. Based on the evaluation, the following control actions are recommended:

Year	Action	Responsible Party	Schedule
2008	2,4-D treatment of Areas A through I in Lees Pond (Figure 1)	Aquatic Control Technology, Inc.	May/June
	Suction harvesting of small patches or regrowth	Hired contractors	July through September
	Hand-pulling of small patches and/or benthic barrier placement	DES/hired divers/local divers	July through September
	Weed Watching and Lake Hosting Activities	Local residents	June through September
	Site Assessment	DES	August/September
2009	Suction harvesting of small patches or regrowth	Hired contractors	July through September
	Hand-pulling of small patches and/or benthic barrier placement	DES/hired divers/local divers	July through September
	Weed Watching and Lake Hosting Activities	Local residents	June through September
2010	Suction harvesting of small patches or regrowth	Hired contractors	July through September
	Hand-pulling of small patches and/or benthic barrier placement	DES/hired divers/local divers	July through September
	Weed Watching and Lake Hosting Activities	Local residents	June through September
	Site Assessment	DES	August/September
2011	Suction harvesting of small patches or regrowth	Hired contractors	July through September
	Hand-pulling of small patches and/or benthic barrier placement	DES/hired divers/local divers	July through September
	Weed Watching and Lake Hosting Activities	Local residents	June through September
2012	Suction harvesting of small patches or regrowth	Hired contractors	July through September
	Hand-pulling of small patches and/or benthic barrier placement	DES/hired divers/local divers	July through September

Year	Action	Responsible Party	Schedule
	Weed Watching and Lake Hosting Activities	Local residents	June through September
	Site Assessment	DES	August/September
2013	Update Management Plan	DES and Interested Parties	Fall

- Approximately 11.3 acres of the waterbody will be impacted by the herbicide treatment (approximately 6% of the surface area).

- The Department of Agriculture will impose standard short-term use restrictions for specified days depending on the use (irrigation, contact, etc) and the herbicide used. The shoreline will be posted and public notice will be made.

- By recommending follow-up management practices that utilize integrated plant management strategies such as benthic barrier placement and hand-pulling re-growth, variable milfoil re-growth or population expansion can be slowed. The lake association and the town of Moultonborough have committed funds and diver assistance towards this project.

- Based on the types of native plants that are mixed in with the stands of variable milfoil (Figure 2) where herbicide application is recommended there are no significant impacts to native plant communities. It is expected that a well distributed stand of native aquatic plants will remain following herbicide application.

- It is important to realize that aquatic herbicide applications are conducted in a specific and scientific manner, and that the herbicides that are used can be target-specific when used at appropriate doses/concentrations: this means that the invasive plant can be removed and native plants favored in this type of control practice. *Not all aquatic plants will be impacted as a result of an herbicide treatment.*

- Because this is a natural system that is being evaluated for management, it is impossible to accurately predict a management course over five years that could be heavily dependent on uncontrolled natural circumstances (weather patterns, temperature, etc). This management plan should be considered a dynamic document that is geared to the actual field conditions that present themselves in this waterbody. If circumstances arise that require the modification of part or all of the recommendations outline here, all interested parties will be consulted for their input on revisions that may be needed to further the goal of variable milfoil management in the subject waterbody.

Figure 1- Map of Milfoil Infestation

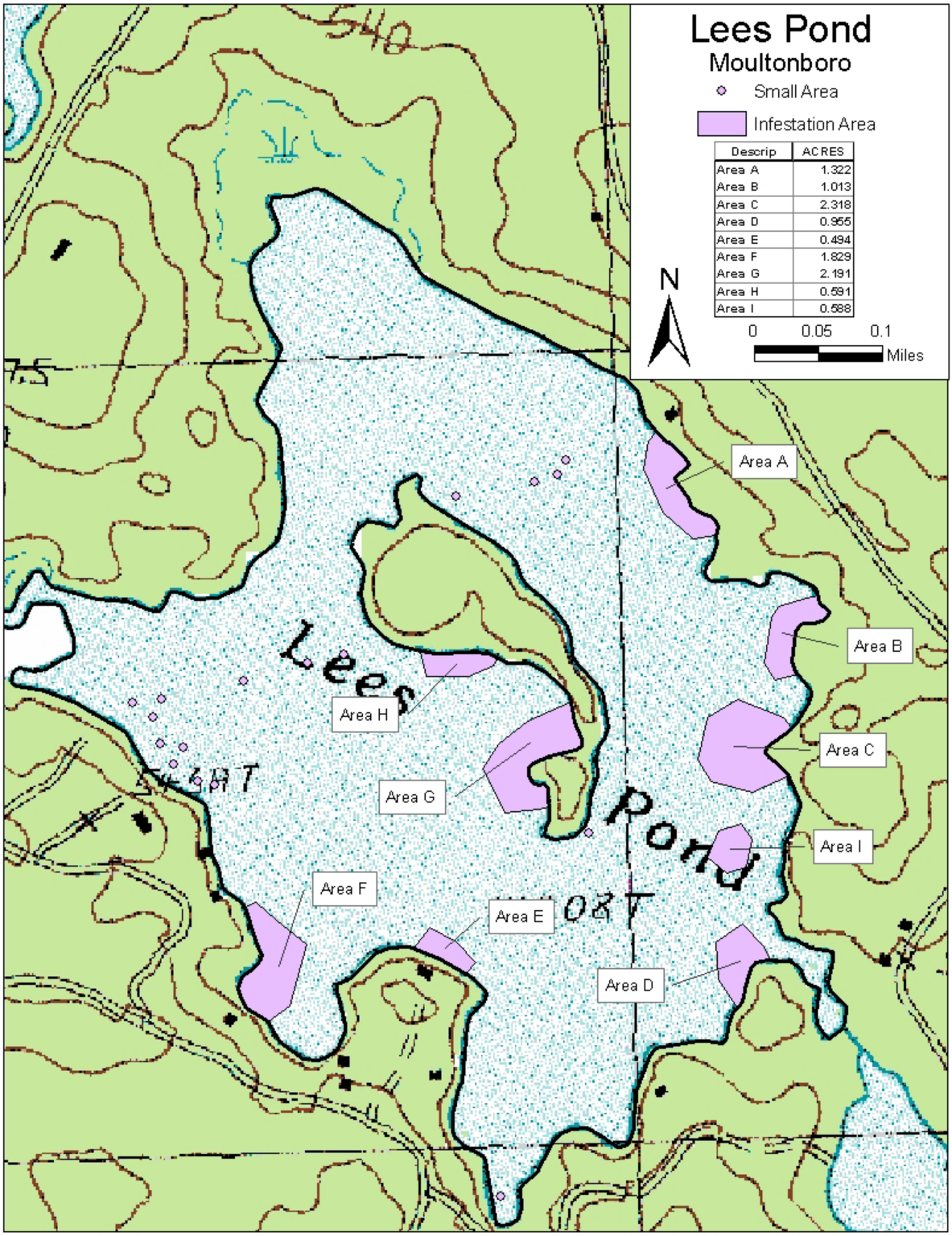
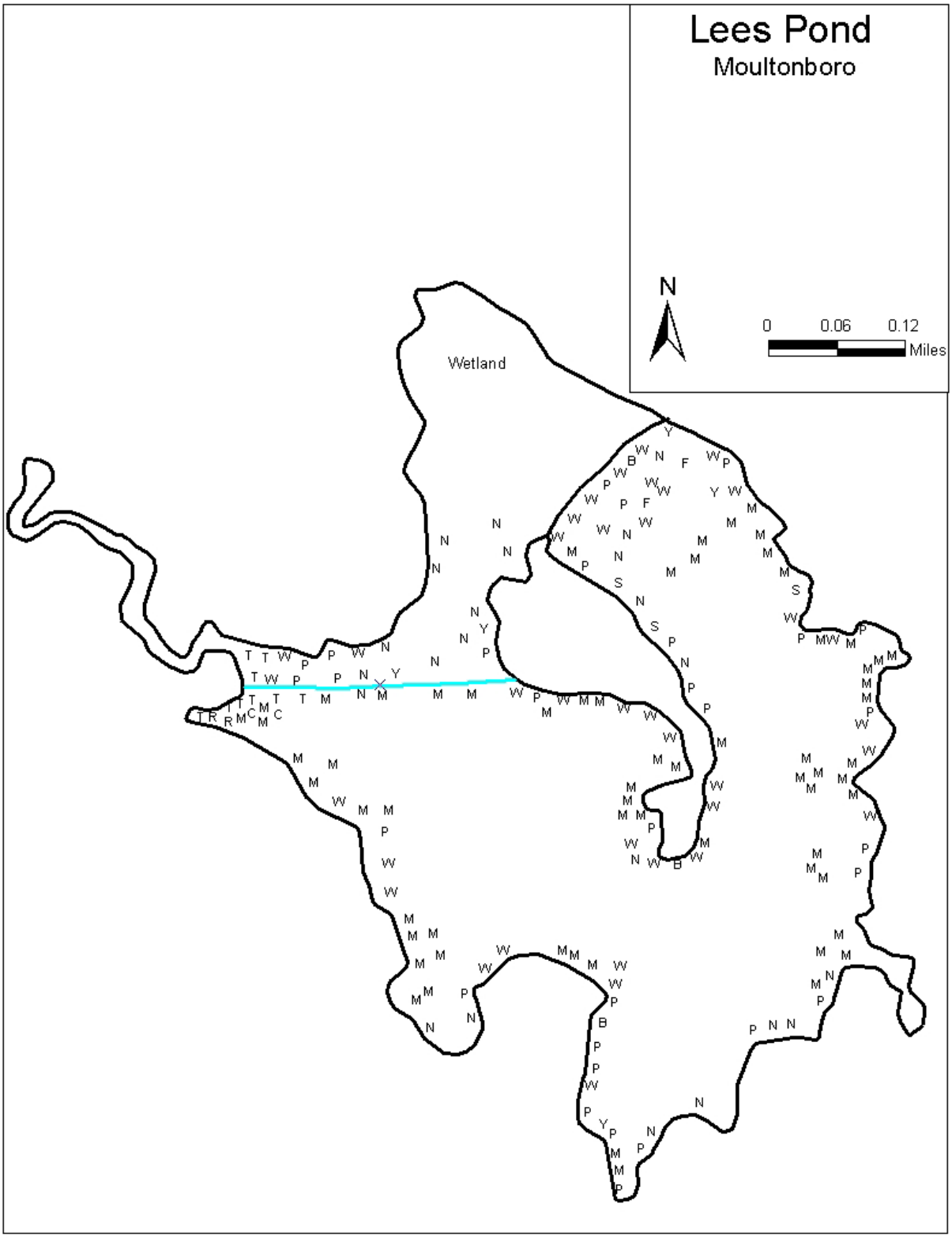


Figure 2- Aquatic Vegetation Map and Key



Symbol	Common Name	Latin Name
S	Bur-reed	*Sparganium*
Y	Yellow water-lily	*Nuphar*
N	White water-lily	*Nymphea*
M	Variable milfoil	*Myriophyllum heterophyllum*
P	Pickerelweed	*Pontedaria cordata*
W	Pondweed	*Potamogeton sp.*
B	Watershield	*Brasenia schreberi*
F	Floating heart	*Nymphoides cordata*
T	Cattail	*Typha*
U	Bladderwort	*Utricularia*
C	Coontail	*Ceratophyllum*
R	Mermaid-weed	*Proserpinaca palustris*

Figure 3- Bathymetric Map of Lees Pond, Moultonborough

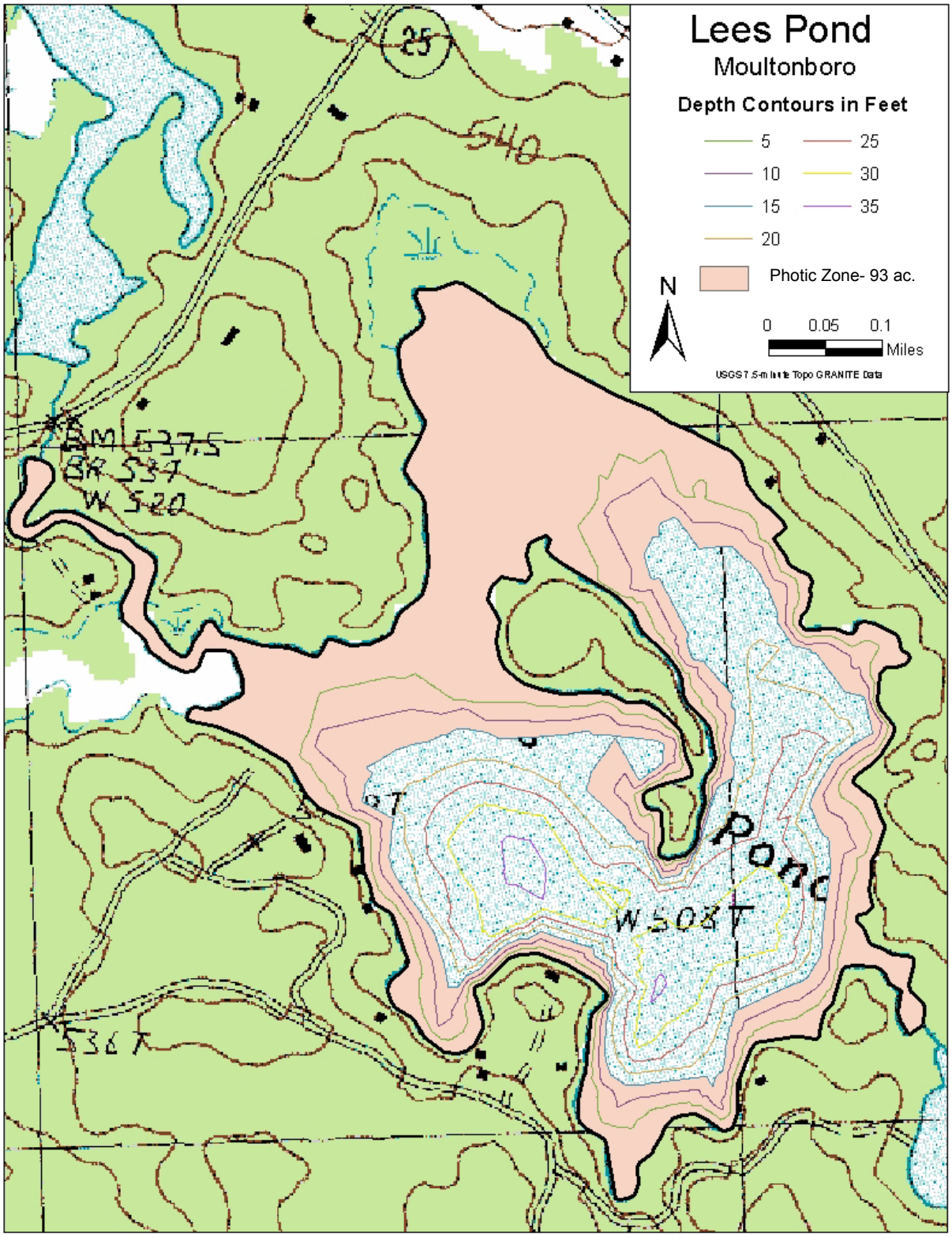


Figure 4- Common Fishing Locations (based on knowledge of lake residents)

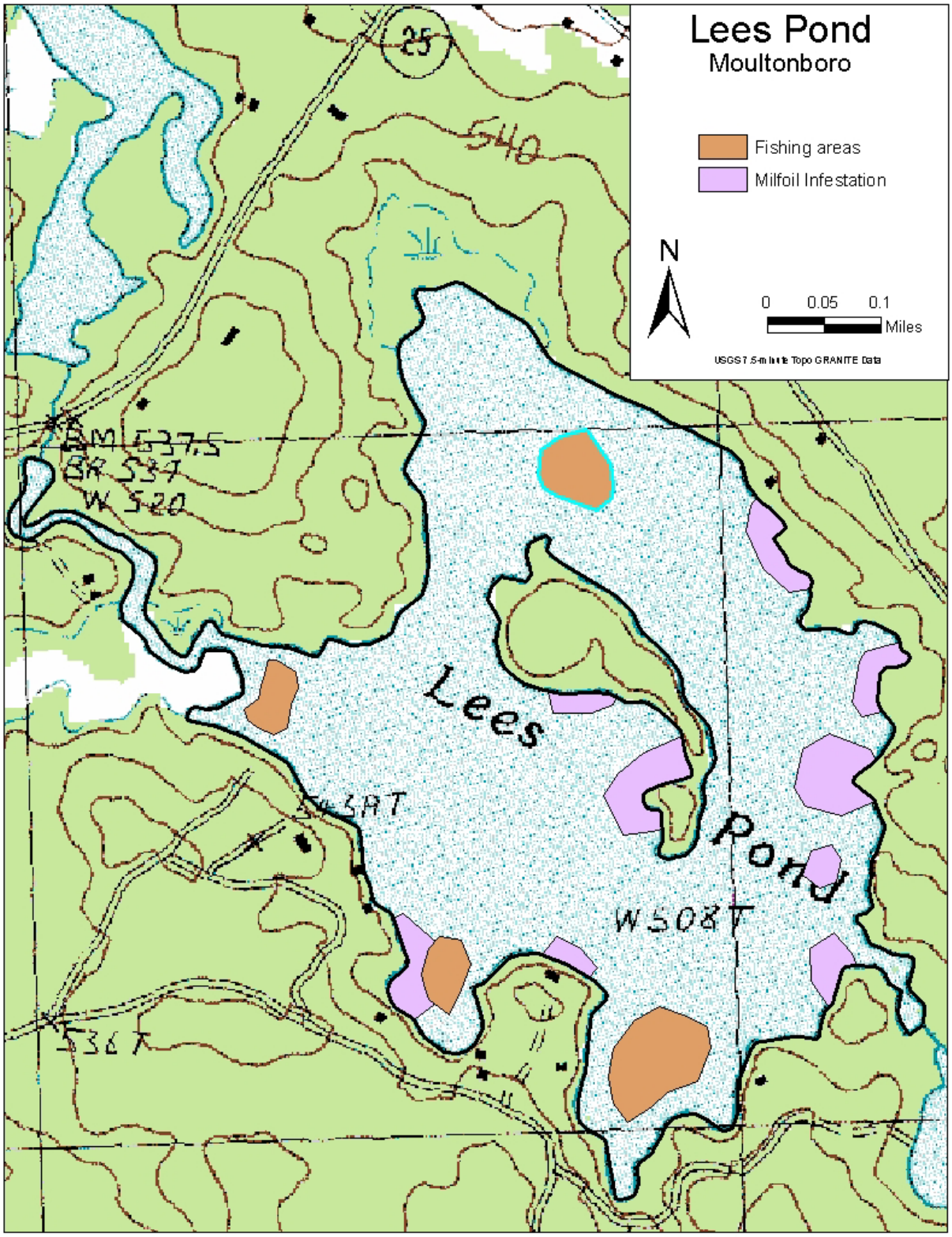


Figure 5- Public Access Points

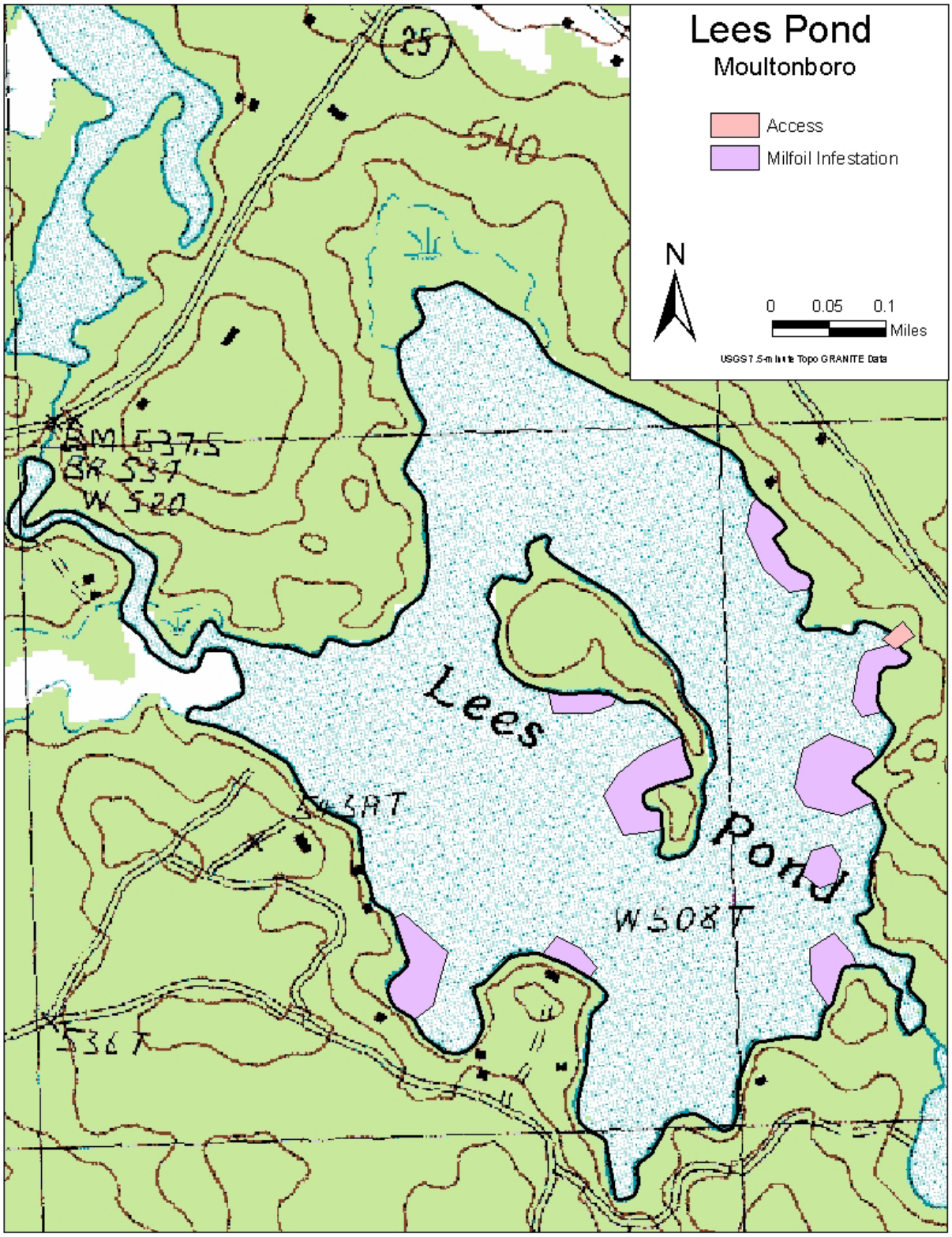


Figure 6- Common Boating Lanes

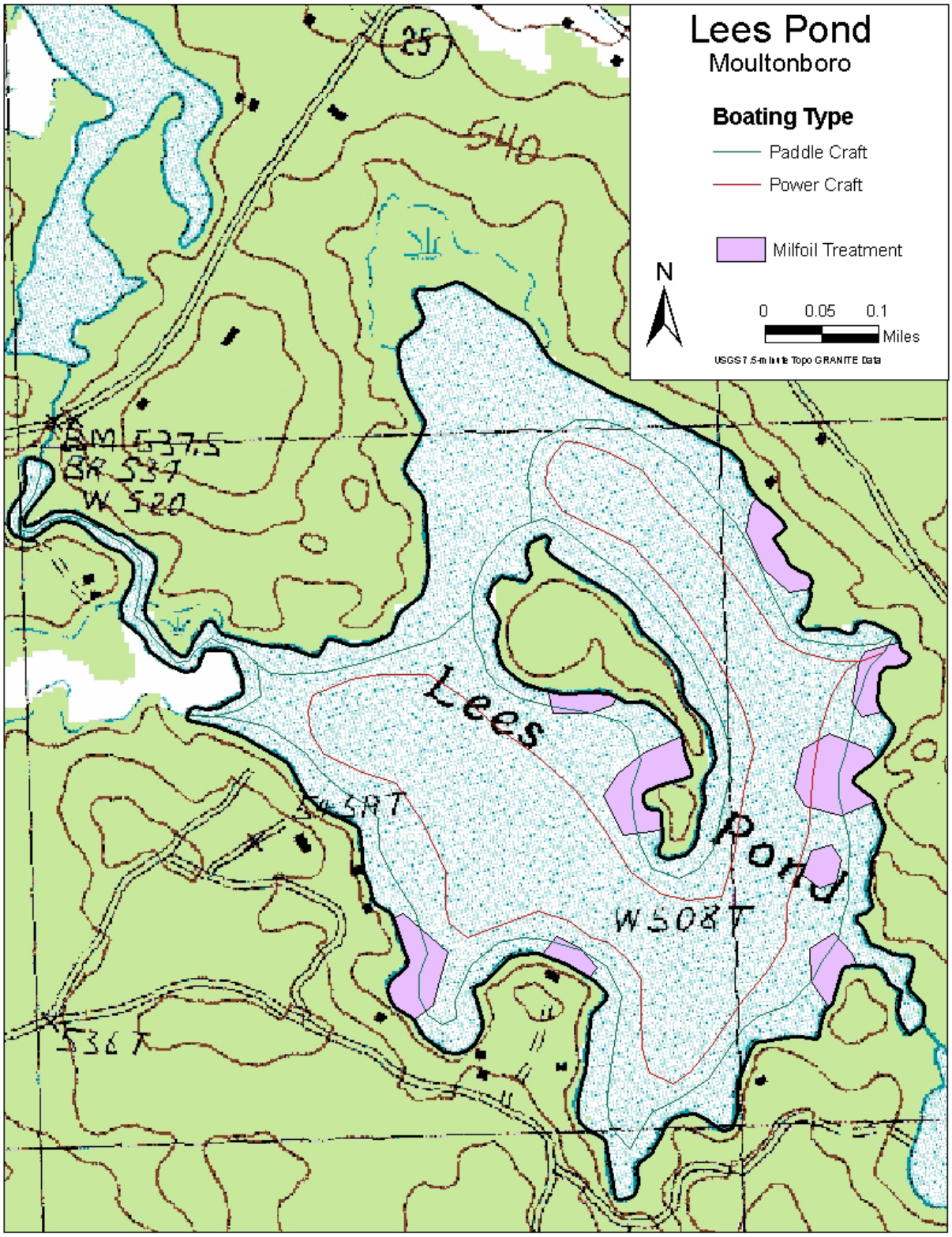
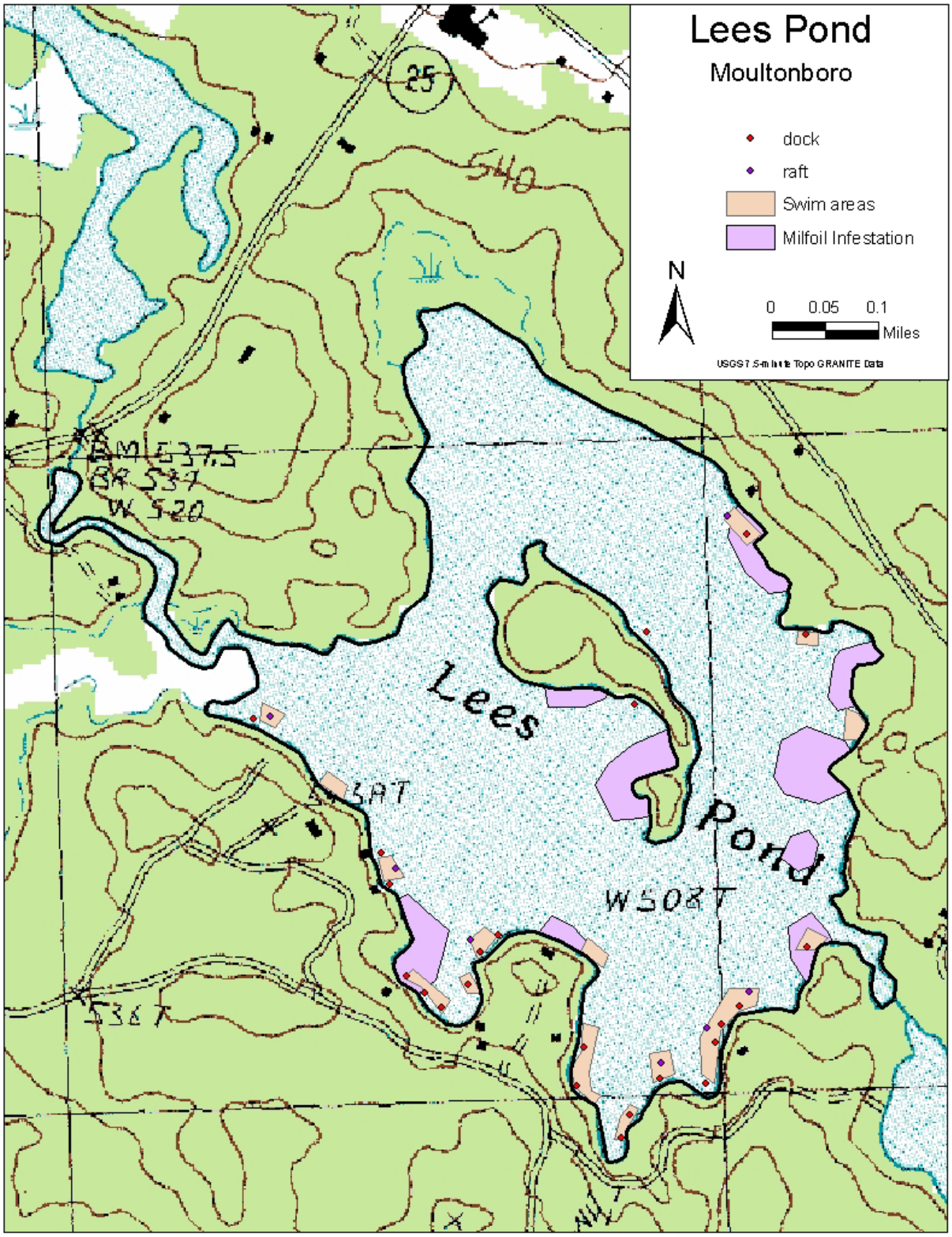


Figure 7- Swim Areas, Swim Platforms/Rafts, Docks



APPENDIX A

CRITERIA TO EVALUATE THE SELECTION OF AQUATIC PLANT CONTROL TECHNIQUES

Preliminary Investigations

I. Field Site Inspection

- Verify genus and species of the plant.
- Determine if the plant is a native or exotic species per RSA 487:16, II.
- Map extent of the plant infestation (area, water depth, height of the plant, density of the population).
- Document any native plant abundances and community structure around and dispersed within the exotic/nuisance plant population.

II. Office/Laboratory Research of Waterbody Characteristics

- Contact the appropriate agencies to determine the presence of rare or endangered species in the waterbody or its prime wetlands.
- Determine the basic relevant limnological characteristics of the waterbody (size, bathymetry, flushing rate, nutrient levels, trophic status, and type and extent of adjacent wetlands).
- Determine the potential impacts to downstream waterbodies based on limnological characteristics (water chemistry, quantity, quality).

Overall Control Options

For any given waterbody that has an infestation of exotic plants, one of three options will be selected, based on the status of the infestation, the available management options, and the technical knowledge of the DES Limnologists who have conducted the field work and who are preparing this plan. The options are as follows:

1) Eradication: Herbicide application targeted at exotic aquatic plant to be eradicated, to either eradicate the plant or to reduce overall biomass to a point where alternative non-chemical strategies may be used. This action will be followed by thorough annual monitoring for regrowth and the use of non-chemical actions to achieve the eradication.

2) Containment: The aim of this approach is to limit the size and extent of the existing infestation. An herbicide application may be used to reduce specified areas down to a percent cover of the exotic species so that it can be maintain or contained with alternative management strategies, including Restricted Use Areas, benthic barriers, and others. Subsequent herbicide applications may be necessary if the target species shows exponential growth and further spread.

3) No action. If the infestation is too large, spreading too quickly, and past management strategies have proven ineffective at controlling the target exotic aquatic plant, DES, in consultation with others, may elect to recommend 'no action' at a particular site. All efforts will instead be made towards containment of the target species to that specific waterbody, so that downstream migration of the plant can be prevented.

If eradication or control is the recommended option to pursue, the following series of control techniques may be employed. The most appropriate technique based on the determinations of the preliminary investigation will be selected.

Guidelines and requirements of each control practice are detailed below each alternative.

A. Hand-Pulling

- Can be used for exotic or native species.
- Can be used if infestation is in a small localized area (sparsely populated patch of up to 5' X 5', single stems, or dense small patch up to 2' X 2').
- Can be used if plant density is low, or if target plant is scattered and not dense.
- Can be used if the plant could effectively be managed or eradicated by hand-pulling a few scattered plants.
- Use must be in compliance with the Wetlands Bureau rules.

B. Mechanically Harvest or Hydro-Rake

- Can not be used on plants which reproduce vegetatively by fragmentation (e.g., milfoil, fanwort, etc.) unless containment can be ensured.
- Can be used only if the waterbody is accessible to machinery.
- Can be used if there is a disposal location available for harvested plant materials.
- Can be used if plant depth is conducive to harvesting capabilities (~ <7 ft. for mower, ~ <12 ft. for hydro-rake).
- Funds are available for repeated harvesting activities in that season.
- A navigation channel is required through dense plant growth.

C. Chemical Treatment

- Can be used if application of chemical is conducted in areas where alternative control techniques are not optimum due to depth, current, use, or type of plant.
- Can be used for treatment of exotic plants where fragmentation is a high concern.
- Can be used where species specific treatment is necessary due to the need to manage other plants (rare or endangered that will not be impacted by chemical treatment).
- Can be used if other methods used as first choices in the past have not been effective.
- A licensed applicator should be contacted to inspect the site and make recommendations about the effectiveness of chemical treatment as compared with

other treatments.

D. Restricted Use Areas (per RSA 487:17, II (d))

- Can be used for exotic species only.
- Can be established in an area that effectively restricts use to a small cove, bay, or other such area where navigation, fishing, and other activities may cause fragmentation to occur.
- Can not be used when there are several "patches" of an infestation of exotic aquatic plants throughout a waterbody.
- Can be used as a temporary means of control.

E. Bottom Barrier

- Can be used for exotic or native species.
- Can be used in small areas, preferably less than 10,000 sq. ft.
- Can be used in an area where the current is not likely to cause the displacement of the barrier.
- Can be used early in the season before the plant reaches the surface of the water.
- Can be used in an area to compress plants to allow for clear passage of boat traffic.
- Can be used in an area to compress plants to allow for a clear swimming area.

F. Drawdown

- Can be used if the target plant(s) are susceptible to drawdown control.
- Can be used in an area where bathymetry of the waterbody would be conducive to an adequate level of drawdown to control plant growth, but where extensive deep habits exist for the maintenance of aquatic life such as fish and amphibians.
- Can be used where plants are growing exclusively in shallow waters where a drawdown would leave this area "in the dry" for a suitable period of time (over winter months) to control plant growth.
- Can be used in winter months to avoid encroachment of terrestrial plants into the aquatic system.
- Can be used if it will not significantly impact adjacent or downstream wetland habitats.
- Can be used if spring recharge is sufficient to refill the lake in the spring.
- Can be used in an area where shallow wells would not be significantly impacted.
- Reference RSA211:11 with regards to drawdown statutes.

G. Dredge

- Can be used in conjunction with a scheduled drawdown.
- Can be used if a drawdown is not scheduled, though a hydraulic pumping dredge should be used.

- Can only be used as a last alternative due to the detrimental impacts to environmental and aesthetic values of the waterbody.

H. Biological Control

- Grass carp cannot be used.
- Exotic controls, such as insects, cannot be introduced to control a nuisance plant.
- Research should be conducted on a potential biological control prior to use to determine the extent of host specificity.

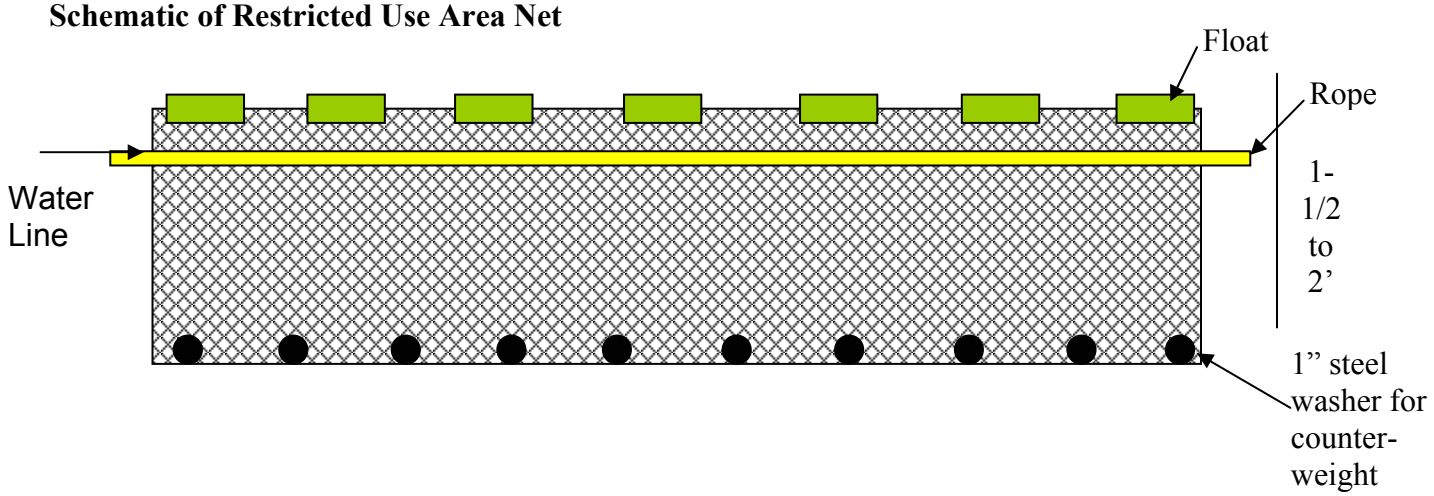
APPENDIX B

SUMMARY OF CONTROL PRACTICES USED IN THE STATE OF NEW HAMPSHIRE FOR EXOTIC AQUATIC PLANTS

Restricted Use Areas:

Restricted Use Areas (RUAs) are a regular control option for lakes with small, contained infestations of exotic plants, limited to small patches or embayments. This is often the case in waterbodies with newly-discovered infestations. RUAs restrict access to all recreational activities in a delineated area to minimize plant fragmentation and thereby reduce the spread of milfoil. As an additional method of protection from fragment migration, RUAs are encircled with a shallow net that is suspended vertically in the water column. The net is approximately 1.5-2.0 feet in height. The top of the net is set to extend four inches above the surface of the water, while the remainder is positioned below the surface of the water (see figure below). This configuration prevents the movement of fragments from infested areas to uninfested areas. Due to the size and nature of net construction, there is no impediment to fish migratory patterns or spawning activities.

Schematic of Restricted Use Area Net



Hand-pulling:

When infestations of exotic aquatic plants begin as single scattered stems or small patches, DES biologists SCUBA dive to hand-pull the plants (and DES can train other certified divers to also perform this management practice). Guidelines for determining feasibility and effective for hand-removal are site specific, but generally sparsely populated patches of up to 5' X 5', single stems, or dense small patch up to 2' X 2' are reasonable.

The whole plant including the roots should be removed in this process, while leaving the beneficial native species intact. This technique works best in softer sediments, with shallow rooted species and for smaller, scattered infestation areas. When hand pulling nuisance species, the entire root system and all fragments of the plants must be collected since small root or stem fragments could result in additional growth of the species. The process must be repeated often to control re-growth of the exotic plants. For a new infestation, hand-pulling activities are typically

conducted several times during the first season, with follow-up inspections for the next 2-5 years or until no re-growth is observed. This control practice has proven successful in many waterbodies.

Mechanical Harvesting

The process of mechanical harvesting is conducted by using machines which cut and collect aquatic plants. These machines can cut the plants up to twelve feet below the water surface. The weeds are cut and then collected by the harvester or other separate conveyer-belt driven device where they are stored in the harvester or barge, and then transferred to an upland site.

The advantages of this type of weed control are that cutting and harvesting immediately opens an area such as boat lanes, and it removes the upper portion of the plants. Due to the size of the equipment, mechanical harvesting is limited to water areas of sufficient size and depth. It is important to remember that mechanical harvesting can leave plant fragments in the water, which if not collected, may spread the plant to new areas. Additionally harvesters may impact fish and insect populations in the area by removing them in harvested material. Cutting plant stems too close to the bottom can result in re-suspension of bottom sediments and nutrients. This management option is only recommended when nearly the entire waterbody is infested, and harvesting is needed to open navigation channels through the infested areas.

Benthic Barriers:

When a small infestation of exotic aquatic plants occurs in clusters of growth (generally areas >5 ft^2), as opposed to scattered stems, a permeable fiberglass screen can be placed over the area of infested lake sediments. The permeable fabric screening allows for gas release from the sediments while effectively blocking sunlight and compressing the plants into the sediment, inhibiting photosynthesis and eventually killing the plant. Occasionally, in some lakes, gas release from the sediments or boating activity cause the uplifting of screening. Benthic barriers can effectively control small infestations of less than approximately 10,000 square feet.

Benthic barriers have two basic applications. These practices are used to cover pioneering infestations and prevent the spread of the plant. Bottom barriers are installed across small portions of lake bottoms infested with invasive aquatic plants. The disadvantage of benthic barriers is their non-selectivity and limitation of cover to less than 10,000 square feet. Additionally, these physical barriers prevent the growth of all vegetation, which is a necessary component of fish and wildlife habitat.

Bottom barriers are attached to the bottom of a water body by re-bar attached to the edges and across the middle of the material. Bottom barriers are transported to the shoreline adjacent to where installation is to occur. They are then cut to fit the treatment site and rolled onto a length of pipe. Divers carry the roll into the water at the start of the treatment site and secure one edge of the material to the lake bottom. The divers then roll out the remainder of the material and continue to secure it to the bottom sediments. This process is repeated until the plants in the treatment are covered.

Bottom barriers are generally considered for small localized areas rather than lakewide application. Bottom barriers provide 100% control of this weed in areas where they are installed. They also provide long-term control. An ongoing maintenance operation is required to inspect the bottom barrier and clear the mats of sediment buildup.

Benthic barriers are not recommended for application in river systems, as flow can easily uplift the barrier.

Targeted Application of Herbicides:

The use of chemicals, such as herbicides, for the control of noxious and nuisance plant species represents one of the most widely known and effective management options available. Herbicide control of invasive aquatic plants is often the first step in a long-term integrated control program. In the last 15 to 20 years the use and review of herbicides has changed significantly in order to accommodate safety, health, and environmental concerns. Currently no herbicide product can be labeled for aquatic use if it has more than a one in a million chance of causing significant harmful effects to human health, wildlife, or the environment. Because of this, the number of effective and U.S. Environmental Protection Agency (EPA) approved herbicides for aquatic weeds are limited. In most cases the cost and time of testing and registration, rather than environmental issues, limits the number of potentially effective compounds.

All herbicide applications in New Hampshire are performed under permits issued by the New Hampshire Department of Agriculture, Division of Markets and Food, Bureau of Pesticide Control.

Two herbicides have been used in New Hampshire for the control of milfoil. Diquat (trade name Reward), the most often-used herbicide, is a contact herbicide that can generally provide one season of control for milfoil. Because this herbicide does not target the root systems, the plants eventually re-grow from established roots.

The second herbicide, 2, 4-D (trade name Navigate or Aqua Kleen), is a systemic herbicide. It is absorbed into the sediments and taken up through the root system, killing both the roots and the plant biomass above the sediments. Label restrictions for aquatic application currently limit its use in New Hampshire to waterbodies with no water intakes, and with no wells adjacent to the shoreline.

The aquatic herbicide SONAR has been used in New Hampshire to control growths of fanwort. The chemical acts by limiting photosynthesis when chlorophyll-a is affected by the active ingredient of the herbicide.

Extended Drawdown

Water drawdown is used for control of some species of aquatic macrophytes. Drawdown requires some type of mechanism to lower water levels, such as dams or water control structures and use is thus limited. It is most effective when the drawdown depth exceeds the depth or invasion level of the target plant species.

In northern areas, drawdown will result in plant and root freezing during the winter for an added degree of control. Drawdown is typically inexpensive and has intermediate effects (2 or more years). However, drawdown can have other environmental effects and interfere with other functions of the water body (e.g. drinking water, recreation, or aesthetics). Drawdown can result in the rapid spread of highly opportunistic annual weed species, which in most cases is the plant that is targeted for control.

Drawdowns have been used in the past for plant control. In theory, the drying of the plants in the summer, or the freezing of the plants in the winter, will eliminate or limit plant growth. However, milfoil often forms a more succulent terrestrial form during drawdown conditions and the succulent form of the plant can remain viable for long periods of time without submergence, making the practice ineffective. This strategy can be used for control of some native plant species.

Dredging

Dredging is a means of physical removal of aquatic plants from the bottom sediments using a floating or land-based dredge. Dredging can create a variety of depth gradients creating multiple plant environments allowing for greater diversity in lakes plant, fish, and wildlife communities. However due to the cost, potential environmental effects, and the problem of sediment disposal, dredging is rarely used for control of aquatic vegetation alone.

Dredging can take place in to fashion, including drawdown followed by mechanical dredging using an excavator, or using a diver-operated suction dredge while the water level remains up.

Biological Control

There are no approved biological controls for submersed exotic aquatic plant at this time in New Hampshire.

REFERENCES

Department of Environmental Services. 2006: 2006 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology. November 2005. New Hampshire Department of Environmental Services. NHDES-R-WD-05-29. Available at http://des.nh.gov/WMB/swqa/calm.html

Halstead, J.M., J. Michaud, S. Hallas-Burt, and J.P. Gibbs. 2003. "An Hedonic Analysis of Effects of a Nonative Invader (*Myriophyllum heterophyllum*) on New Hampshire (USA) Lakefront Properties." Environmental Management. 32 (3): 391 – 398

Luken, J.O. and J.W. Thieret. 1997. Assessment and Management of Plant Invasions. Springer-Verlag, New York. 324 pages.